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Description of a Developmental Series of Larval Broad Whitefish, *Coregonus nasus* (Pallas)

R.A. Ratynski and B.G.E. de March

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TABLE OF CONTENTS

	Page
ABSTRACT/RESUME	iv
INTRODUCTION	1
MATERIALS AND METHODS	1
RESULTS	1
DISCUSSION	2
ACKNOWLEDGMENTS	3
REFERENCES	3

LIST OF TABLES

Table		Page
1	Summary of morphological and meristic measurements by length class for laboratory-reared Coregonus nasus	5
2	Morphometric and meristic measurements for hatchery-raised Coregonus nasus	7

LIST OF FIGURES

Figure		Page
1	Dorsal, lateral, and ventral views of a 10.9 mm TL larva of Coregonus nasus showing external morphology and patterns of pigmentation	9
2	Dorsal, lateral, and ventral views of a 15.4 mm TL larva of Coregonus nasus showing external morphology and patterns of pigmentation	10
3	Dorsal, lateral, and ventral views of a 19.6 mm TL larva of Coregonus nasus showing external morphology and patterns of pigmentation	11
4	Dorsal, lateral, and ventral views of a 19.1 mm TL larva of Coregonus sp. from Tuktoyaktuk Harbour, N.W.T. showing external morphology and patterns of pigmentation	12

ABSTRACT

Ratynski, R.A., and B.G.E. de March. 1989. Description of a developmental series of larval broad whitefish, Coregonus nasus (Pallas). Can. Tech. Rep. Fish. Aquat. Sci. 1670: iv + 12 p.

Morphologic, meristic, and pigmentation characteristics of larval C. nasus, reared from eggs collected and fertilized at Ft. McPherson, N.W.T. and reared under laboratory conditions, are described and illustrated. Characteristics are compared to Eurasian C. nasus and sympatrically occurring coregonid species.

Key words: meristics; pigmentation; arctic fish.

RÉSUMÉ

Ratynski, R.A., and B.G.E. de March. 1989. Description of a developmental series of larval broad whitefish, Coregonus nasus (Pallas). Can. Tech. Rep. Fish. Aquat. Sci. 1670: iv + 12 p.

Les caractéristiques morphologiques, méristiques et pigmentaires de larves de C. nasus élevées en laboratoire à partir d'oeufs recueillis et fertilisés à Fort McPherson, T.N.-O., sont décrites et illustrées. Les caractéristiques sont comparées à celles d'espèces C. nasus eurasiennes et d'espèces sympatriques de corégones.

Mots-clés: méristique; pigmentation; poisson de l'Arctique.

INTRODUCTION

Broad whitefish, Coregonus nasus (Pallas), is one of the most desirable domestic fisheries species in the Mackenzie Delta Region of Canada. The species and its habitat were examined as a NOGAP (Northern Oil and Gas Action Project) subproject of the Department of Fisheries and Oceans in anticipation of environmental disturbances in the Beaufort Sea (de March 1989).

Five species of the subfamily Coregoninae occur sympatrically in the Canadian waters of the southern Beaufort Sea (Bond 1982; Hopky and Ratynski 1983; Lawrence et al. 1984). Adult and juvenile Coregonus autumnalis, C. clupeaformis, C. nasus, C. sardinella, and Stenodus leucichthys are readily identifiable even though there is considerable overlap in morphometric and meristic characteristics (Lindsey 1962; McPhail and Lindsey 1970). Although the larval ecology of coregonids is of interest, the identification of larval stages has not been attempted because of inadequate descriptions (Ratynski 1983). The objectives of this study were to examine a developmental series of C. nasus reared from eggs in the laboratory. Morphologic, meristic, and pigmentation characteristics that have diagnostic value in distinguishing the species from sympatric cogeners were recorded and the larval series illustrated. For comparison, descriptions of larval C. clupeaformis from other locations are available (Faber 1970; Hinrichs 1979; Cucin and Faber 1985; Fudge et al. 1986). C. nasus larvae from Soviet waters were described by Bogdanov (1983) and larvae of S. leucichthys were described by Hinrichs (1979). However, there is no information on C. autumnalis or C. sardinella.

MATERIALS AND METHODS

Adult C. nasus were collected from the Peel River near Fort McPherson, N.W.T. (de March 1989) on 25 October, 1986 and the eggs and milt obtained from 7 females and 2 males. Fertilized eggs were transported to the Freshwater Institute, Winnipeg, Manitoba, where they were incubated in jars at a mean temperature of 4°C. Temperatures occasionally reached 10°C because of technical difficulties. Beginning on 23 December, 2-3 fish hatched per day. On 21 January, 1987, hatching was forced by raising the temperature to 7°C, so that previously hatched fish would not die from the tumbling in the incubators. Approximately 2,000 - 3,000 fish hatched within 4 hours. Larvae were fed live Artemia from swim-up until 16 March, then two successive sizes of a moist starter pellet, Biodiet®. Because of unexpected rapid growth caused by the change to Martens-Feed, no samples between 22.5 and 29.5 mm total length were obtained.

Small larvae were preserved in 5% non-buffered formalin and juveniles in 10% non-buffered formalin. Specimens were examined with the aid of a stereomicroscope. Morphometric measurements were determined with an ocular micrometer calibrated with a micrometer slide. Body lengths of juveniles were determined with dial-reading calipers. Body lengths were measured to the nearest 0.1 mm and all other measurements to the nearest 0.01 mm.

The following measurements and counts were made: Standard Length (SL)-the distance from the snout tip to notochord tip prior to caudal fin development, thereafter to the posterior margin of the superior hypural bone; Total Length (TL)-the distance from the snout tip to the most posterior point on the fin fold or caudal fin; Preanal Length (PAL)-the distance from the snout tip to the most posterior point of the anus; Postanal Length (PTAL)- the distance from the most posterior point of the anus to the most posterior point on the finfold or caudal fin; Head Length (HL)- the distance from the snout tip to the posterior edge of the opercle; Head Depth (HD)- vertical distance from dorsal to ventral head margin posterior to the eye; Eye Diameter (ED)- horizontal diameter of left orbit; Body Depth-(BD) vertical distance from dorsal to ventral body margin at the pectoral fin base; Preanal Myomeres (PAMY)- number of muscle segments from the nape to, and including any myomeres bisected by, an imaginary vertical line at the most posterior point of the anus; Postanal Myomeres (PTAMY)- number of muscle segments posterior to an imaginary vertical line at the most posterior part of the anus (not including the urostylar element); and Total Myomeres (TMY)- number of muscle segments from the nape to the last myoseptum.

Terminology for SL, HL, ED and BD is from Matarese et al. (1981) and for TL, PAL, PTAL, PAMY and PTAMY (except that the urostylar element has not been included) is from Auer (1982). Illustrations of larvae were drawn based on the techniques described in Faber and Gadd (1983).

RESULTS

MORPHOLOGY

C. nasus at hatching ranged from 9.8 - 10.9 mm TL (mean 10.5 mm; standard error 0.17; n=6) or from 9.7 - 10.4 mm SL (mean 10.1; standard error 0.14; n=6). Lengths and other measurements are summarized for each 2 mm TL interval (Table 1). Raw data are in Table 2.

The mouth was inferior at hatching and remained so throughout development. The yolk sac was almost absorbed by approximately 13.4 - 14.0 mm TL (12.7 - 13.6 mm SL) at which time the pelvic fins became visible (but without rays) and there were indications of caudal rays developing. Dorsal and anal fin rays began to develop by approximately 15.4 mm TL (14.1 mm SL). Pelvic fin rays appeared by 16.8 mm TL (14.9 mm SL). Developing pectoral fin rays became visible at 20.3 mm TL (18.0 mm SL). All fin rays were complete on a specimen measuring 29.5 mm TL (24.5 mm SL); however, no specimens between 22.5 - 29.5 mm TL were available for measurement. Notochord flexion began at 14.0 mm TL (12.8 mm SL) and was completed by 18.5 mm TL (16.2 mm SL). A remnant of finfold was visible anterior to the anus on a specimen as large as 33.0 mm TL (27.3 mm SL). Juvenile characteristics were at-

tained by 41.0 mm TL (33.4 mm SL).

MERISTICS

The total number of myomeres for the smallest length class ranged from 54-61, with a mean of 57.22. Preanal myomeres averaged 42.11 and postanal myomeres 15.11. Results were similar for the next largest length class (Table 1).

PIGMENTATION

Lateral. The yolk sac of the smallest larvae had a scattering of melanophores (Fig. 1); there was also a row on either side of the intestine which continued to the anus. A few melanophores were present along the posterior end of the notochord. By 15.4 mm TL (14.1 mm SL), a few melanophores were scattered laterally on the gut (Fig. 2). Later, melanophores appeared at the base of the eyes and scattered on the body; some appeared on the lateral line posteriorly (Fig. 3). Melanophores eventually spread over the upper half of the body with some developing on the opercula.

Ventral. Melanophores were scattered on the yolk sac and a row of melanophores was present on either side of the fin fold extending from the anus to the caudal fin (a continuation of the rows formed on the lateral gut) (Fig. 1). By 15.4 mm TL (14.1 mm SL), a distinct mid-line band of pigment,beginning just anterior to the pectoral fin bases, formed on the ventral gut (Fig. 2). This band was visible on all similar-sized or larger specimens (Fig. 3) and was present, but less distinct, on the largest specimen examined (46.0 mm TL; 37.5 mm SL).

Dorsal. Yolk sac larvae were characterized by pigmentation on the head and by a row of melanophores on either size of the mid-line extending from just anterior to the pectoral fin bases to the caudal end. There were also additional melanophores between the above rows anteriorly (Fig. 1). Pigmentation eventually became more prevalent on the head, along the mid-line, and also appeared on the snout (Fig. 2 and 3).

DISCUSSION

Newly hatched C. nasus (9.7 - 10.4 mm SL; mean 10.1 mm) described by this study were smaller than those described by Bogdanov (1983) for Soviet waters (10.5 - 14.0 mm SL; mean 12.3). Although the possibility of true differences exists, the smaller size could be the result of relatively high incubation temperatures and/or early forced hatching. The range of preanal myomeres (41-46) was similar to the 41 - 45 reported by Bogdanov (1983), but postanal myomeres were fewer in number (13-17) compared to 22-26 for Soviet waters. Lebedeva (1976 in Bogdanov 1983) gave a range of total myomeres (57-61) similar to the range found in this study (Table 1).

Pigmentation was typical for coregonines which, in preflexion and flexion larvae, is mostly associated with the dorsal and ventral mid-lines (Bogdanov 1983; Kendall and Behnke 1984). Pigmentation later becomes more uniform over the body.

C. nasus larvae appear very similar to C. clupeaformis larvae from Southern Indian Lake, Manitoba, which at 10.8 - 15.7 mm TL, had preanal myomere counts ranging from 39 - 43 and postanal counts ranging from 10 - 20 (Fudge et al. 1986). This overlaps with counts for C. nasus as determined in this study (Table 1). Fin ray counts for the two species also overlap (Scott and Crossman 1973). Ratios of body measurements or counts have not been considered in this study, but these may demonstrate differences between the two species.

Pigmentation was also similar for C. nasus and C. clupeaformis. C. clupeaformis larvae from Southern Indian Lake had the same characteristic scattering of melanophores or mid-line band of melanophores on the ventral gut (Fudge et al. 1986). C. clupeaformis also had a similar double row of melanophores dorsally extending from the head to the caudal fin. However, in the few yolk sac larvae from Southern Indian Lake that we examined, these dorsal melanophores were less numerous and not as evenly paired as in similar-sized C. nasus. However, this characteristic varied considerably among C. clupeaformis larvae.

In an effort to provide additional information, a few coregonid larvae captured during a 1982 study of Tuktoyaktuk Harbour (Ratynski 1983) were re-examined. The four specimens ranged from 19.1 - 40.0 mm TL (17.3 - 34.5 mm SL). Except for the smallest which had a slightly inferior mouth, all had terminal mouths and as a result are probably cisco (either C. autumnalis or C. sardinella). The C. nasus examined in this study all had inferior mouths. If, as seems likely, C. autumnalis and C. sardinella have an inferior mouth at smaller sizes, as reported by Hinrichs (1979) for the ciscoes C. artedii and C. hoyi, they could be difficult to distinguish from similar-sized larval whitefish. S. leucichthys are distinguished by a terminal mouth at hatching and older larvae never have an inferior mouth (Hinrichs 1979). Preanal myomeres on these Tuktoyaktuk "ciscoes" numbered 41-44, which overlaps with the number for both C. nasus (this study) and C. clupeaformis from Southern Indian Lake. These "ciscoes" also had the same dorsal melanophore rows extending from the head to the caudal and the characteristic mid-line band of pigment on the ventral gut as found in C. nasus larger than 14.1 mm SL (this study) and in C. clupeaformis larger than 18.0 mm SL from Southern Indian Lake (Fudge et al. 1986). Only 1% of larval C. artedii larger than 18.0 mm SL from Southern Indian Lake had even a faint mid-gutline of melanophores and in these the number of pigment cells was always less than 15 and usually less than 10 (Fudge et al. 1986). The only apparent difference from C. nasus was that lateral line pigmentation was more pronounced, extending from just posterior of the pectoral fin bases to the caudal (Fig. 4).

This study has described some morphologic,

meristic, and pigmentation characteristics that may have diagnostic value in distinguishing larval C. nasus from other coregonid larvae occurring sympatrically in the Mackenzie Delta region. Unfortunately, larval C. autumnalis and C. sardinella have not yet been fully described and the published descriptions of larvae of the other sympatrically occurring coregonid species are based on samples from different systems. Thus, the extreme morphological plasticity and evolutionary diversity of coregonid species may limit the usefulness of any comparisons made to these samples. It is suggested that spawn from all the coregonid species occurring in the Mackenzie Delta be obtained and the eggs incubated and the larvae reared under the same laboratory conditions. Morphometric, meristic, and pigmentation characteristics obtained from these samples, combined with biochemical methods of separation, should allow the development of a reliable means of identifying field samples of larval coregonids. Only then will ecologists begin to unravel the complexities of the early life histories of these very important components of the fish fauna of the Mackenzie Delta southern Beaufort Sea.

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Table 1. Summary of morphological and meristic measurements by length class for laboratory reared Coregonus nasus. TL = mm total length, PAL = mm preanal length, PTAL = mm postanal length, HL = mm head length, HD = mm head depth, ED = mm horizontal diameter of left orbit, BD = mm vertical distance from dorsal to ventral body margin at the pectoral fin base, PAMY - number of preanal myomeres, PTAMY = number of postanal myomeres, and TMY = number of muscle segments from the nape to the last myoseptum. More details in text.

Length Range (mm)	Character	n	Minimum	Maximum	Mean	Standard Error of Mean
9.0-10.9 (TL)	PAL	10	6.7	7.7	7.2	0.08
	PTAL	10	3.1	3.7	3.4	0.06
	HL	10	1.48	1.82	1.66	0.04
	HD	10	1.25	1.50	1.37	0.03
	ED	10	0.69	0.88	0.76	0.02
	PAMY	9	41	46	42.11	0.61
	PTAMY	9	13	17	15.11	0.39
	TMY	9	54	61	57.22	0.64
11.0-12.9 (TL)	PAL	10	7.4	8.4	7.9	0.09
	PTAL	10	3.6	4.2	4.0	0.06
	HL	10	1.70	2.13	1.99	0.04
	HD	10	1.25	1.52	1.43	0.03
	ED	10	0.74	0.97	0.88	0.02
	BD	8	1.39	1.54	1.47	0.02
	PAMY	6	41	45	41.67	0.67
	PTAMY	6	14	17	15.67	0.49
	TMY	6	55	60	57.33	0.71
13.0-14.9 (TL)	PAL	17	8.7	10.0	9.5	0.08
	PTAL	17	3.9	5.0	4.3	0.06
	HL	17	2.08	2.88	2.51	0.04
	HD	17	1.54	1.84	1.65	0.02
	ED	17	0.94	1.14	1.04	0.02
	BD	17	1.28	1.81	1.50	0.03
15.0-16.9 (TL)	PAL	10	9.9	11.8	10.8	0.16
	PTAL	10	4.7	5.9	5.2	0.11
	HL	10	3.00	3.99	3.39	0.10
	HD	10	1.78	2.29	2.05	0.06
	ED	10	1.20	1.46	1.29	0.03
	BD	10	1.60	2.02	1.76	0.05
17.0-18.9 (TL)	PAL	10	11.4	12.7	12.1	0.12
	PTAL	10	5.5	6.2	5.8	0.07
	HL	10	3.78	4.25	4.00	0.05
	HD	10	2.10	2.64	2.44	0.05
	ED	10	1.36	1.63	1.45	0.03
	BD	10	1.88	2.48	2.22	0.05

Table 1. continued

Length Range (mm)	Character	n	Minimum	Maximum	Mean	Standard Error of Mean
19.0-20.9 (TL)	PAL	10	12.5	14.0	13.2	0.13
	PTAL	10	6.0	7.4	6.4	0.13
	HL	10	3.74	4.99	4.31	0.12
	HD	10	2.29	3.10	2.69	0.09
	ED	10	1.50	1.90	1.60	0.04
	BD	9	2.04	2.58	2.37	0.07
21.0-22.9 (TL)	PAL	9	13.1	14.8	14.3	0.17
	PTAL	9	7.3	8.7	7.5	0.18
	HL	9	4.40	5.00	4.78	0.07
	HD	8	2.90	3.50	3.20	0.08
	ED	9	1.67	1.90	1.81	0.03
	BD	9	2.42	3.27	2.81	0.09
31.0-32.9 (TL)	PAL	4	20.8	21.2	20.9	0.09
	PTAL	4	10.6	11.6	11.2	0.24
	HL	4	6.88	8.08	7.58	0.26
	HD	3	4.12	4.88	4.59	0.24
	ED	4	2.30	2.94	2.57	0.13
	BD	4	4.73	5.38	5.02	0.15
33.0-34.9 (TL)	PAL	2	21.4	22.3	21.8	0.45
	PTAL	2	11.2	11.6	11.4	0.20
	HL	2	8.18	8.19	8.18	0.01
	HD	2	4.93	5.15	5.04	0.11
	ED	2	2.40	2.64	2.52	0.12
	BD	2	4.98	5.06	5.02	0.04
35.0-36.9 (TL)	PAL	6	21.5	23.8	22.4	0.35
	PTAL	6	12.0	14.1	13.2	0.31
	HL	6	8.14	9.38	8.45	0.20
	HD	5	5.38	6.10	5.83	0.13
	ED	6	2.66	3.40	3.03	0.10
	BD	6	5.06	5.70	5.46	0.12
40.0-46.0 (TL)	PAL	5	25.7	28.5	27.3	0.48
	PTAL	5	14.1	18.1	15.7	0.71
	HL	5	9.82	10.12	10.09	0.08
	HD	5	6.12	7.06	6.67	0.18
	ED	5	3.12	3.74	3.54	0.11
	BD	5	6.20	7.06	6.65	0.15

Table 2. Morphometric and meristic measurements for hatchery raised Coregonus nasus.

FISH #	TL (mm)	SL (mm)	PAL (mm)	PTAL (mm)	HL (mm)	HD (mm)	ED (mm)	BD (mm)	PAMY	PTAMY	TMY	
1	9.8	9.7	6.7	3.1	1.48	1.40	0.75	-	-	-	-	Yolk sac larva
3	10.3	9.8	7.0	3.3	1.65	1.45	0.84	-	41	16	57	Yolk sac larva
2	10.5	10.0	7.2	3.3	1.60	1.50	0.75	-	44	14	58	Yolk sac larva
12	10.5	9.9	6.9	3.6	1.78	1.30	0.77	-	41	16	57	Yolk sac partially absorbed
9	10.6	10.3	7.1	3.5	1.60	1.25	0.72	-	43	15	58	Yolk sac partially absorbed
4	10.8	10.3	7.3	3.5	1.59	1.34	0.70	-	41	13	54	Yolk sac larva
6	10.8	10.5	7.2	3.6	1.55	1.50	0.82	-	41	15	56	Yolk sac larva
10	10.8	10.3	7.2	3.6	1.78	1.40	0.70	-	41	17	58	Yolk sac partially absorbed
5	10.9	10.4	7.2	3.7	1.82	1.30	0.88	-	41	15	56	Yolk sac larva
11	10.9	10.5	7.7	3.2	1.78	1.32	0.69	-	46	15	61	Yolk sac partially absorbed
7	11.0	10.6	7.4	3.6	1.88	1.30	0.74	-	41	15	56	Yolk sac partially absorbed
8	11.4	10.9	7.8	3.6	1.70	1.25	0.74	-	45	15	60	Yolk sac partially absorbed
19	11.6	11.0	7.6	4.0	2.13	1.50	0.94	1.50	41	14	55	Yolk still visible
13	11.9	11.4	7.9	4.0	1.95	1.42	0.91	1.39	41	17	58	Yolk still visible
16	11.9	11.3	7.8	4.1	2.02	1.50	0.91	1.44	41	17	58	Yolk still visible
20	11.9	11.3	8.0	3.9	1.92	1.39	0.84	1.39	-	-	-	Yolk still visible
89	12.0	11.4	8.0	4.0	2.10	1.47	0.97	1.52	41	16	57	Yolk almost absorbed
14	12.1	11.5	8.1	4.0	1.97	1.52	0.90	1.50	-	-	-	Yolk still visible
17	12.1	11.6	8.0	4.1	2.12	1.50	0.90	1.54	-	-	-	Yolk still visible
15	12.6	12.0	8.4	4.2	2.10	1.48	0.90	1.45	-	-	-	Yolk still visible
25	13.0	12.4	9.1	3.9	2.34	1.60	0.98	1.45	-	-	-	Yolk still visible
18	13.1	12.6	8.7	4.4	2.08	1.54	0.95	1.57	-	-	-	Yolk still visible
33	13.4	12.7	9.3	4.1	2.57	1.55	1.00	1.35	-	-	-	Yolk almost gone; pelvic fin buds visible; caudal rays beginning to form?
32	13.5	12.8	9.1	4.4	2.52	1.66	1.04	1.47	-	-	-	Yolk gone; pelvic fin buds visible
26	13.6	12.8	9.5	4.1	2.44	1.58	1.02	1.49	-	-	-	Yolk visible; pelvic fin buds
28	13.7	13.1	9.4	4.3	2.55	1.61	1.01	1.40	-	-	-	Yolk visible; pelvic fin buds; caudal rays forming
27	13.8	13.1	9.4	4.4	2.38	1.71	0.95	1.52	-	-	-	Yolk visible; pelvic fin buds; caudal rays forming
30	13.8	13.3	9.7	4.1	2.52	1.63	0.96	1.45	-	-	-	As above
22	13.9	13.2	9.4	4.5	2.55	1.68	1.09	1.56	-	-	-	As above
29	13.9	13.3	9.6	4.3	2.31	1.62	0.94	1.48	-	-	-	As above
21	14.0	13.6	9.8	4.2	2.45	1.70	1.10	1.50	-	-	-	As above
23	14.0	13.3	9.6	4.4	2.46	1.72	1.08	1.55	-	-	-	As above
31	14.0	13.5	9.8	4.2	2.61	1.84	1.01	1.81	-	-	-	Partial yolk sac; pelvic fin buds
39	14.0	12.8	9.6	4.4	2.60	1.72	1.12	1.55	-	-	-	Notochord flexion beginning? dorsal fin base forming
37	14.2	12.9	9.2	5.0	2.88	1.57	1.14	1.42	-	-	-	Notochord flexion occurring; dorsal fin rays beginning; yolk gone
38	14.2	13.2	9.8	4.4	2.74	1.70	1.14	1.28	-	-	-	Notochord flexion; yolk gone; dorsal rays forming
24	14.3	13.6	10.0	4.3	2.59	1.66	1.07	1.58	-	-	-	Notochord flexion, but some yolk visible; no sign of dorsal rays
36	15.4	14.1	10.7	4.7	3.21	1.92	1.21	1.76	-	-	-	Flexion larva; caudal rays and signs of dorsal and anal fin development
75	15.5	14.1	10.6	4.9	3.22	2.20	1.20	1.75	-	-	-	Flexion; dorsal, anal rays forming
76	15.6	14.5	4.8	4.8	3.10	1.82	1.24	1.68	-	-	-	Flexion
35	15.7	14.5	10.7	5.0	3.19	1.92	1.24	1.70	-	-	-	Flexion
34	15.8	13.7	9.9	5.9	3.00	1.78	1.20	1.60	-	-	-	Flexion
46	15.8	14.4	10.6	5.2	3.45	2.04	1.31	1.67	-	-	-	Flexion
40	16.1	14.6	10.9	5.2	3.48	2.10	1.29	1.62	-	-	-	Flexion
42	16.5	14.8	11.2	5.3	3.50	2.24	1.30	1.90	-	-	-	Flexion
41	16.8	15.0	11.3	5.0	3.80	2.20	1.42	1.95	-	-	-	Flexion
70	16.8	14.9	11.3	5.5	3.99	2.29	1.46	2.02	-	-	-	Pelvic fin rays visible; flexion
68	17.2	15.2	11.4	5.8	3.85	2.10	1.43	1.88	-	-	-	Pelvic fin rays visible; flexion
53	17.6	15.6	12.1	5.5	3.98	2.40	1.36	2.38	-	-	-	As above; anal and dorsal

Table 2. Morphometric and meristic measurements for hatchery raised C. nasus (continued).

FISH #	TL (mm)	SL (mm)	PAL (mm)	PTAL (mm)	HL (mm)	HD (mm)	ED (mm)	BD (mm)	PAMY	PTAMY	TMY	
74	17.6	15.7	11.6	6.0	3.98	2.39	1.48	2.20	-	-	-	Notochord flexion nearing completion
48	17.7	15.7	12.0	5.7	3.78	2.45	1.36	2.13	-	-	-	Flexion nearly completed
43	17.8	15.7	12.0	5.8	3.85	2.64	1.37	2.34	-	-	-	Flexion nearly completed
45	18.0	16.0	12.4	5.6	4.02	2.33	1.39	2.31	-	-	-	Flexion nearly completed
47	18.0	16.0	12.1	5.9	4.06	2.52	1.48	2.23	-	-	-	As above; pelvic, dorsal, and anal fin rays still forming
71	18.0	16.0	12.1	5.9	4.16	2.44	1.50	2.09	-	-	-	Flexion completed?
54	18.5	16.2	12.5	6.0	4.25	2.63	1.63	2.46	-	-	-	Post flexion
44	18.9	16.9	12.7	6.2	4.03	2.54	1.48	2.20	-	-	-	Post flexion
52	19.1	16.8	12.5	6.6	4.00	2.29	1.50	2.04	-	-	-	Post flexion
58	19.1	16.5	12.7	6.4	4.40	2.88	1.59	2.43	-	-	-	Post flexion
69	19.1	16.8	13.1	6.0	4.08	2.46	1.56	2.12	-	-	-	Post flexion
77	19.5	17.3	13.4	6.1	3.74	2.50	1.60	2.43	-	-	-	Post flexion
51	19.6	17.2	13.5	6.1	4.17	2.56	1.53	2.45	-	-	-	Post flexion; caudal fin beginning to fork
55	19.6	18.3	13.3	6.3	4.44	3.10	1.60	2.56	-	-	-	As above
73	19.7	17.2	13.1	6.6	4.05	2.40	1.60	2.16	-	-	-	Post flexion
49	20.1	17.8	13.4	6.7	4.40	2.68	1.54	2.54	-	-	-	Post flexion; finfold remains anterior to anus
50	20.3	18.0	14.0	6.3	4.83	3.08	1.54	-	-	-	-	Post flexion; pelvic, dorsal and anal fin rays still developing; no rays on pectorals?
78	20.4	17.0	13.0	7.4	4.99	2.95	1.90	2.58	-	-	-	Post flexion; with pectoral fin rays?
80	21.2	18.0	13.9	7.3	5.00	3.28	1.90	2.68	-	-	-	Post flexion; with pectoral fin rays
72	21.3	18.8	14.4	6.9	4.69	2.90	1.75	2.65	-	-	-	As above
57	21.4	18.7	14.5	6.9	4.81	3.00	1.83	2.79	-	-	-	As above
82	21.4	18.4	14.1	7.3	4.74	3.40	1.90	2.70	-	-	-	As above
79	21.6	18.5	14.4	7.2	4.82	-	1.74	2.69	-	-	-	As above; pelvic rays seem complete
56	21.8	19.6	13.1	8.?	4.40	2.90	1.67	2.42	-	-	-	Post flexion; pectoral fin rays forming
59	22.1	18.7	14.6	7.5	4.94	3.37	1.72	3.04	-	-	-	As above
60	22.5	19.0	14.7	7.8	5.00	3.50	1.84	3.27	-	-	-	Post flexion; remnant of finfold anterior to anus; pectoral fin rays almost complete
81	22.5	18.9	14.8	7.7	4.62	3.24	1.90	3.03	-	-	-	Post flexion; pectoral fin rays forming
62	29.5	24.5	18.8	10.7	6.64	2.75	2.36	2.85	-	-	-	Post flexion; all fin rays at or near completion; remnant of finfold anterior to anus
63	31.4	26.2	20.8	10.6	8.08	4.88	2.48	4.73	-	-	-	Post flexion; fin rays completed
66	32.1	26.3	20.9	11.2	6.88	4.12	2.30	4.84	-	-	-	Post flexion; remnant of finfold
86	32.4	26.8	20.8	11.6	7.56	-	2.94	5.38	-	-	-	Juvenile features appearing (eg. silver sheen on eyes, etc.)
61	32.8	27.7	21.2	11.6	7.81	4.76	2.55	5.15	-	-	-	Remnant of finfold anterior to anus
64	33.0	27.3	21.4	11.6	8.19	4.93	2.64	4.98	-	-	-	As above
65	33.5	28.2	22.3	11.2	8.18	5.15	2.40	5.06	-	-	-	Post flexion
83	35.0	28.1	21.8	13.2	8.28	-	2.66	5.06	-	-	-	Post flexion
84	35.4	30.0	22.4	13.0	8.62	5.89	3.12	5.36	-	-	-	Post flexion
88	35.6	28.6	21.5	14.1	8.14	5.76	3.00	5.40	-	-	-	Post flexion
93	35.8	29.1	23.8	12.0	9.38	6.10	3.40	5.70	-	-	-	Body taking on silver sheen of juvenile
85	35.9	30.9	23.1	12.8	8.18	5.38	2.99	5.38	-	-	-	Post flexion
87	35.9	29.8	22.0	13.9	8.11	6.02	3.00	5.89	-	-	-	Post flexion
67	40.2	32.8	25.7	14.5	10.20	6.12	3.12	6.46	-	-	-	Post flexion
92	41.0	33.4	26.9	14.1	9.82	6.40	3.74	6.20	-	-	-	Post flexion/juvenile
90	43.7	35.0	27.5	16.2	10.06	6.88	3.70	6.75	-	-	-	Juvenile
94	44.1	37.1	28.5	15.6	10.26	7.06	3.65	6.78	-	-	-	Juvenile
91	46.0	37.5	27.9	18.1	10.12	6.88	3.50	7.06	-	-	-	Juvenile

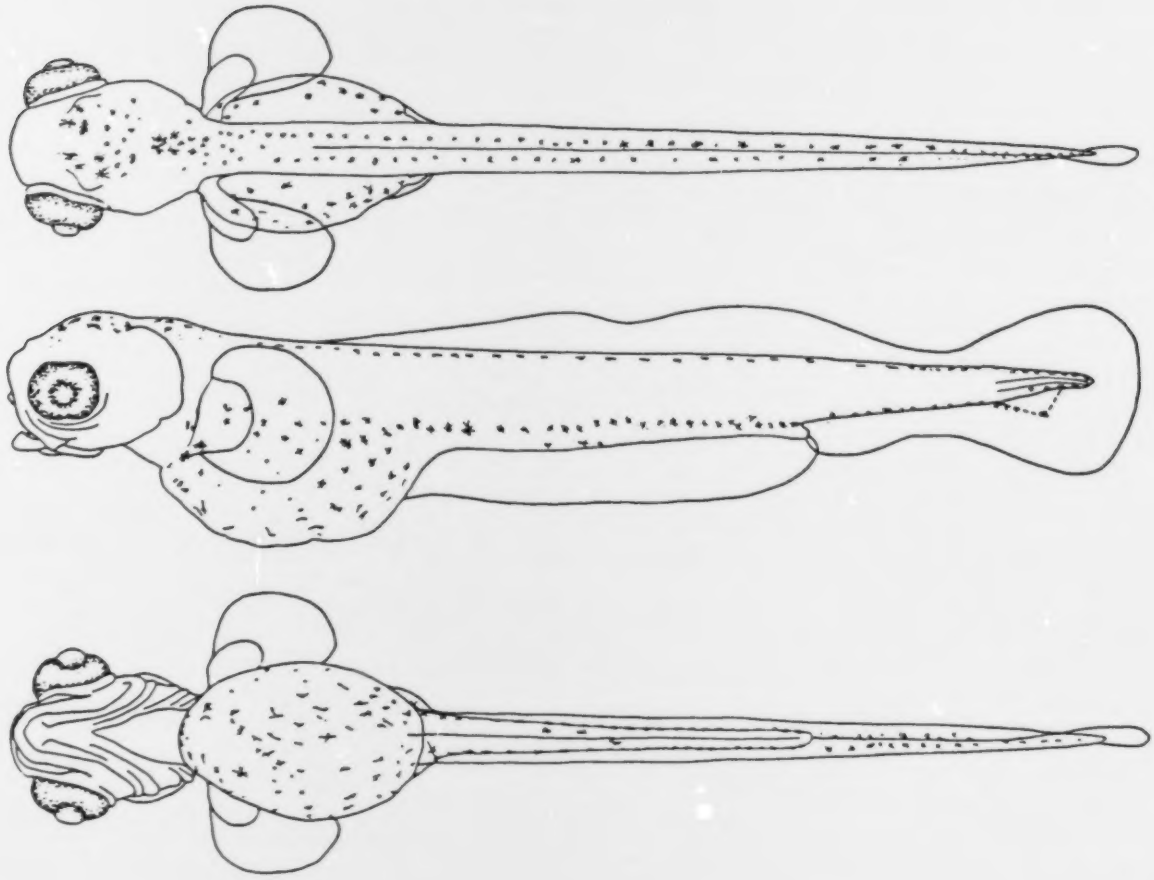

Fig. 1. Dorsal, lateral, and ventral views of a 10.9 mm TL (10.5 mm SL) larva of Coregonus nasus showing external morphology and patterns of pigmentation.

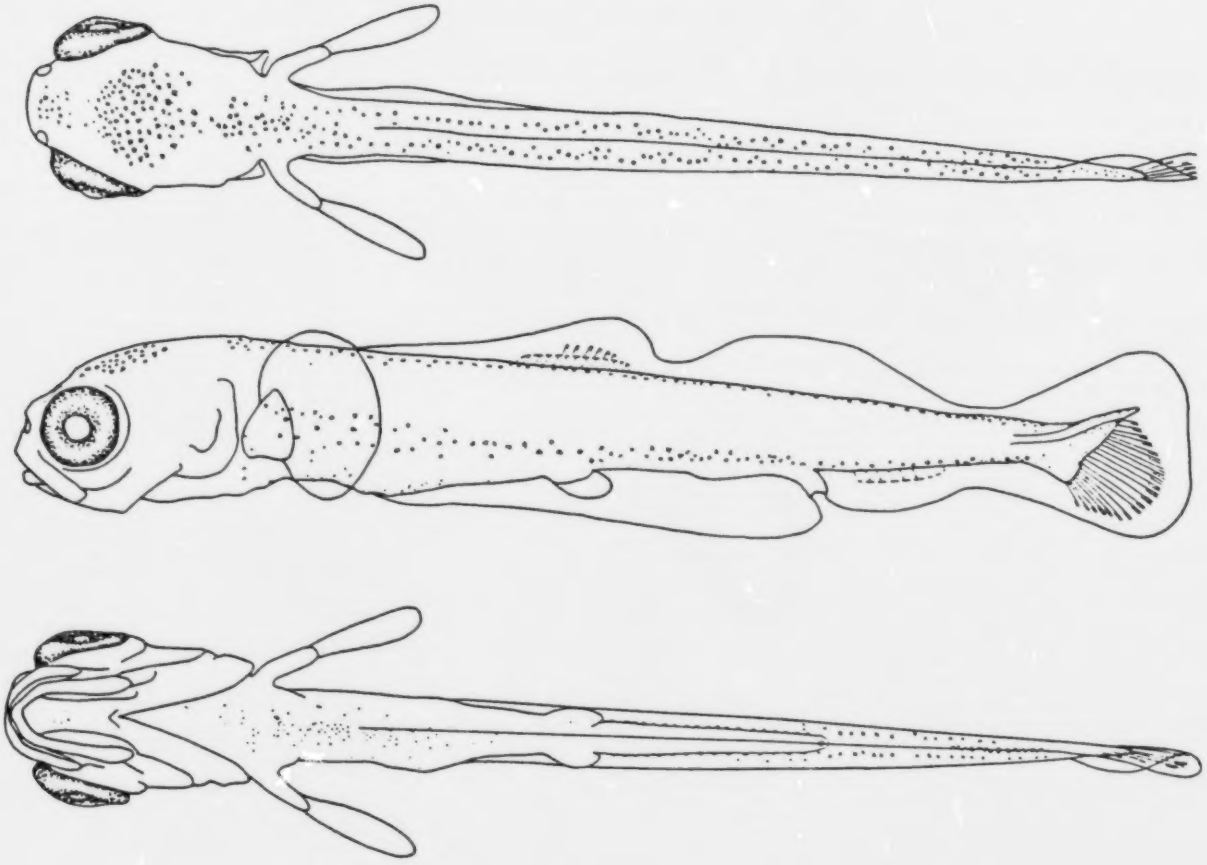

Fig. 2. Dorsal, lateral, and ventral views of a 15.4 mm TL (14.1 mm SL) larva of Coregonus nasus showing external morphology and patterns of pigmentation.

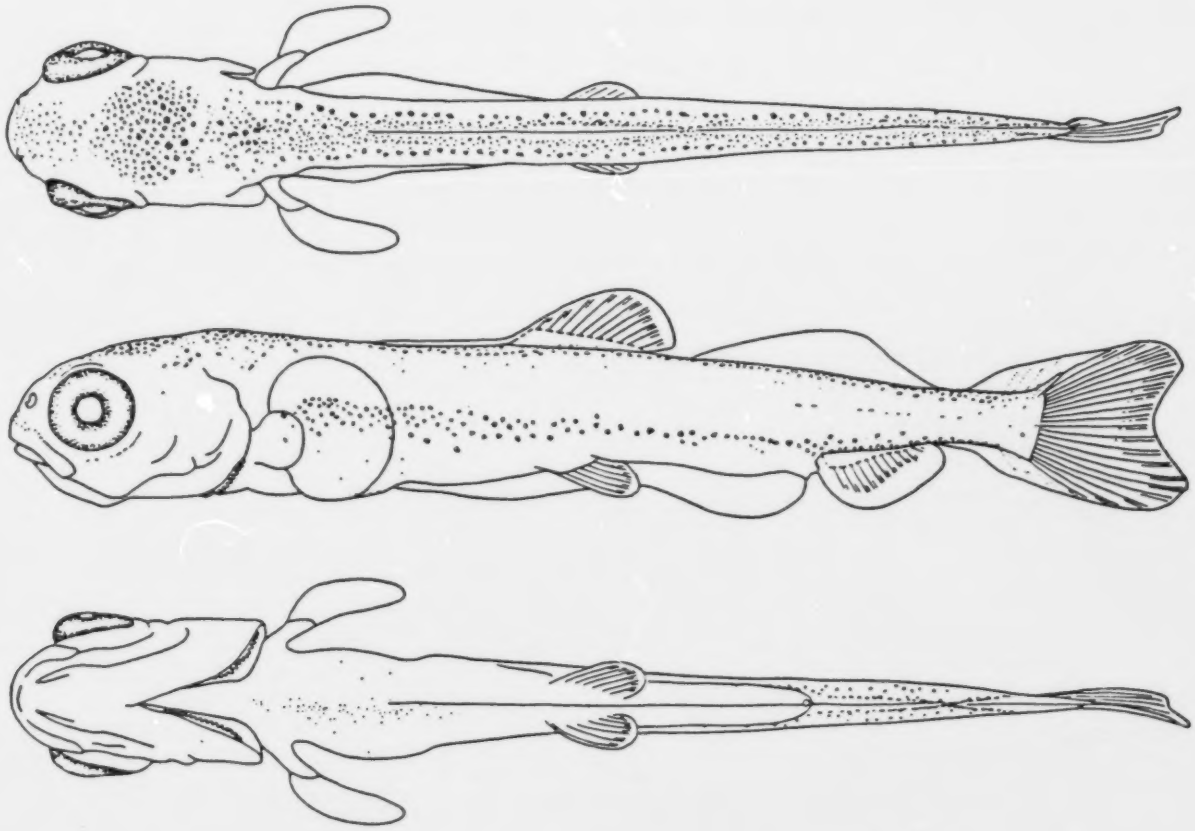

Fig. 3. Dorsal, lateral, and ventral views of a 19.6 mm TL (17.2 mm SL) larva of Coregonus nasus showing external morphology and patterns of pigmentation.

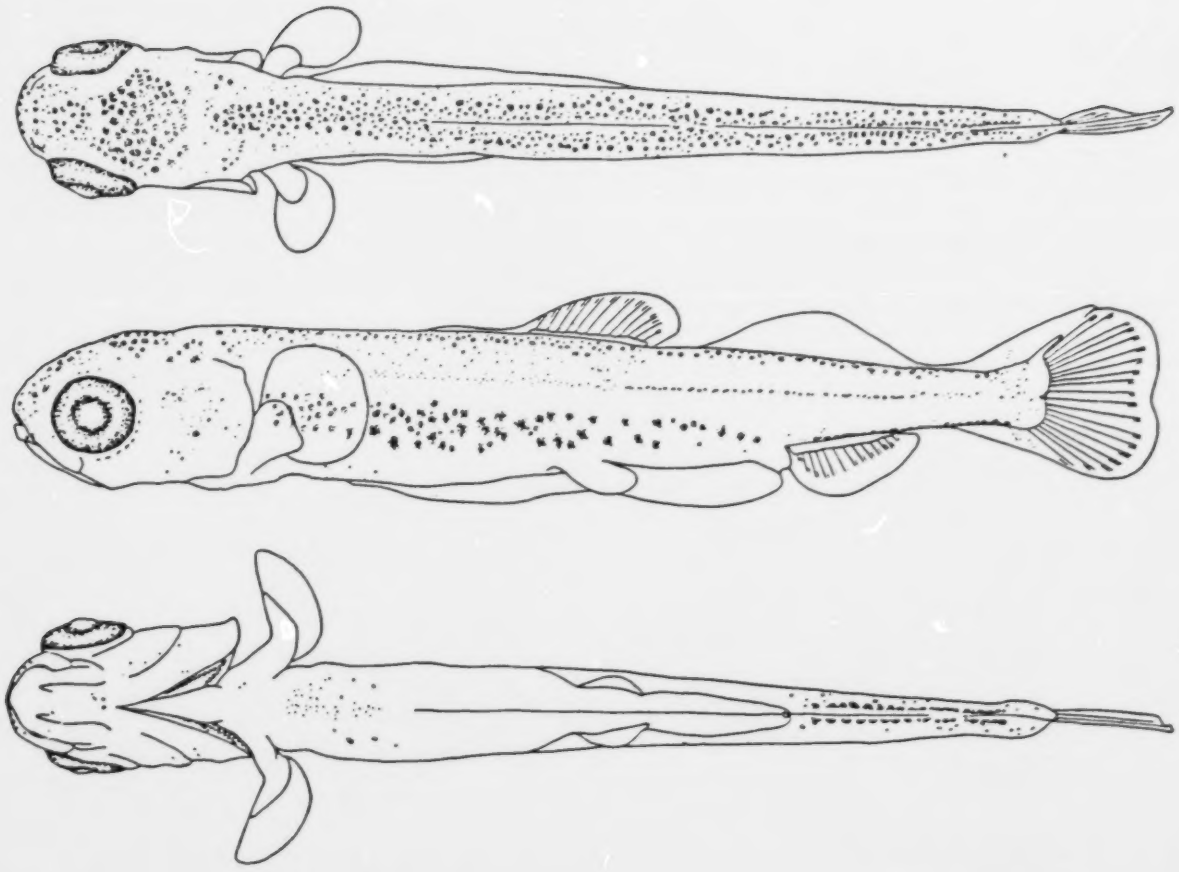

Fig. 4. Dorsal, lateral, and ventral views of a 19.1 mm TL (17.3 mm SL) larva of Coregonus sp. from Tuktoyaktuk Harbour, N.W.T. showing external morphology and patterns of pigmentation.